

Fuelling the Future of a Billion Poor JABA Village's Experiment with ADIRE

#### "Alternate Development Initiatives with Renewable Energy"

**D**.**P. Kar**, PhD Student. (Mineral Economics), Colorado School of Mines, and Senior Rate Planner, Wisconsin Public Service Corporation **Carol Dahl**, Professor and Head of CSM/IFP, Division of Economics and Business, Colorado School of Mines, Golden, Colorado, 80401, USA

25th USAEE/IAEE North America Conference, Denver, Colorado, September 18-21, 2005

# **Central Points of Experiment**

#### **Global Problem**

✤ Grid Business Failure in Rural India and other Rural Economies is not Surprising

- High Cost of Grid in Rural Areas Where 70-80% of People Live
- Grid Did Not Create Adequate Rural Income for its Commercial Feasibility
- Urbanization may not solve rural income and standard of living issues

#### Local Solution

- Real Life Experiment if Solar, Biogas, Biomass, (possibly) Biodiesel, and Complementary Frontier Technologies
  - Can Generate Rural Income and Solve Energy Affordability Issues?
  - Are Affordable and Least Cost?
  - Are Compatible with the Cultural Etho?

# Energy & Income Poverty Indian Sub Continent and Africa



Energy & Income

Global Setting

#### Source: WEO 2002, IEA

# Fuel of Growth for A Billion Rich

(Approx PPP GDP 1985 USD / Capita from Robert Lucas AER, 2004)

#### A threshold issue of income and energy

Energy & Income

Global Setting

Year	USA/ UK	France/	Japan	India
Dominant fuel		Germany		
1800 Muscle power	600	600	600	600
1850 bydro / wind	1200	600	600	600
1900 Coal	3600	1200	600	600
1950 <sub>Oil</sub>	7200	3600	1200	600
2000 Electricity -coal, nuclear,gas	16000 330m	12000 140m	14000 120m	1200 1000m(People)



# The Problem in India

- India has 600,000 villages of 700 million people of which only 30% have electricity and clean cooking fuel
- Very remote possibility of connecting all the villages to grid system
- Manure and low cost wood are widely used as cooking fuel creating health hazards
- > People crowding nearby cities in search of better quality of lives



- Does not get the quality of service, attention, and problem resolution as promptly
- The incidence of theft through illegal connections is generally higher. T&D loss 5 b dollar. 20-50% of generation
- ➢ Lines/ MW connected load > 7 −10 times



# **Rising Expectation**



Many Kerosene Lamps in Electrified Homes!!!

High-CostLow Consumption

Income & Electricity Share as % of Income



#### When Income is Low

- A law and order issue
- Government change in India

# **Electric Price Going Up**

- 😼 Grid, An Increasing Cost Industry
- Pollution, No more Grandfathered
- Cross Subsidy, In Market Places?
- Perfect Storms, Terrorism/Cyclones Chasing Reliability/Safety/Security?
- Risks of investment

Energy & Income

- Technology, Regulation, Lumpy Scale Economy

### So What to Do?

Wove All Villagers to Urban Area? No more.

Take a Modern Grid to Rural Area? Do not work.

bo Not Do Anything. Let the Capitalism Trickle Down.

> Do Something Cleaner and Better

### **Urban Capitalism?**

Energy & Income

Global Setting

700m in India, 750 m in China and 1b Rural People Elsewhere:
•Cut-off from Modern Consumption and Production Process.
•Cut off from Pollution Costs Too? Probably Not.

China rural incomes last year averaged \$355, a third of urban incomes. 26 million rural Chinese live in absolute poverty, \$80 a year. http://edition.cnn.com/2005/WORLD/asiapcf/08/22/china.stability.reuter

In India, although much of the west and south may have a large middle class by 2020, a number of [rural] regions such as Bihar, Uttar Pradesh, and Orissa will remain underdeveloped

**Report of the National Intelligence Council's 2020 Project** 

Orissa (30 million people, 80%) is less than 100 dollar! This is the place where we did the experiment

# Pitfalls and Risks

#### Politics of Regulation and Wealth Redistribution

 Effective regulation, social security, and low income support not very easy where 80% are poor, have no access to food, shelter, education and information to bargain and influence market decisions.

#### Costs Shifting has been Problematic

Energy & Income

Global Setting

- Pollution Costs, Energy, Health, Insurance Risks
- ➢ No Incentive to Support Poor Countries
  - Aid for Tsunami/Hurricane/Earthquake:humanitarian not economic
  - Market Solution with Barter, Illiteracy, Zero information.
- Global Firms' Reluctant to Enter Rural Market



What Grameen Bank's Md. Yunus Says

- Foreign aid is <u>less apt</u> to accelerate economies or to improve people's lives.
  - The only people benefiting from this aid are those who are already wealthy, though they do so in the name of the poor".
- economic growth from the bottom up.



### Low Risk Clean Technologies for Rural Capitalism

#### **Rural Residences**

- Solar Light/Appliances
- Biogas Cooking
- Low Cost Rural Housing /Low Cost Health
- Solar Home (Coming Soon)

#### **Rural Business and Industry**

- Biomass/Biogas Power
- Micro Hydro/Mini Grid
- -Complementary Production
- -Rural Finance / Health/ Insurance/ Education

#### **Rural Transportation**

- Minimized Travel/ Healthy Bicycle Mobility
- Bio Diesel Bus/Car(Coming Soon)
- Agricultural Tractor/Machinery need Biodiesel

### **DEVELOPMENT PATH TO MODERNITY (ADIRE)**





# A D I R E Project's Uniqueness

#### Can We Bypass Energy ladder?

ADIRE Case Study

- Leapfrog from Manual / Ancient Biomass to Modern Solar/Biogas/Biomass
- Small Hydro and Wind only if Available and Economic
- Distributed Energy and Dispersed Development
  - Test Energy Income Chain, Can Small Clean Energy Systems Generate Income?
- Modern Management with Modern Technology
  - Individual and Self Help Group driving Government and International Agencies
  - SPV Powered LED, Laptop, LCD TV, and Internet Complementing Low Cost Housing
- Thrust on Income Near Family and Happy Life
  - Rural Employment
  - Beautifying and Modernizing Rural Areas to Keep the Cities Beautiful



# **Demography and Lifestyle**

- Population
- Households
- Farm Earners
- Cash Earners
- Toilets
- Water Pump
- Energy in households
  - Wood/ Dung
  - Kerosene
  - Electricity
  - LPG
  - Biogas Cooker
  - Solar Lantern

417

All

All

40

6

22

- 100 (Income < 100\$/m)
- 4 (Income > 500\$/m)
- 87 (21%) 135 Acres
- 48 (12%) Jobs/Business
- 30 +30 from 2003
- 10 +10 from 2003

from 1970

from 1995

from 2003

**2+2** from 2003







# Energy Use in JABA in 2002 with Their Cash Cost

	Quantity	Price US Cents	Total Cost USD	% Income spent
Electricity	100 kWh	6	6	6%
Biomass	80 kg	3	2.4	2.4%
Cattle Manure	10 kg	2	0.2	0.2%
Kerosene	3 liters	22	0.6	0.6%

#### ADIRE Case Study

#### Solution for Lighting Up

Fully Loaded Cost in Indian Rupee, INR/month (USD)

Technology	Grid	Kerosene	Solar PV Iantern
Capital	25	0	50
Primary Fuel	45	105	0
Back-up Fuel	75	0	35
Labor	90	180	20
Total	235 (5\$)	285 (6\$)	105 (2.2\$)

That is Why Solar Lights?

Household Saves 2.8-3.8\$/month = 40\$/year

For 138 million HHs =5.5 billion \$/year

# Facts of Renewable Electricity

#### を Too little?

Case Study

- Poor can only afford a little (Kerosene Vs. Solar Lamp)
- Add in small increments later

#### Too Intermittent and unreliable?

- Grid Unavailable or Unreliable too
- Cooling/heating/irrigation do not need continuous supply
- Can use hybrid models



#### Cannot be stored?

- Easy to store at sub-kWh level
- Willing to schedule and conserve to minimize storage
- First Conserve, Then, Design and Use (Combo Solar Lamp, TV, Laptop and Radio)



# Solution for Clean Cooking Costs In INR/month (USD)

Technology	LPG	Kerosene	Biogas	Wood
Capital / Stove	1000	200	5000	10
Primary Fuel	375	400	0	250
Back-up Fuel	0	0	20	20
Labor	20	100	20	100
Total	405 (9\$)	505 (12\$)	100 (2.2\$)	370(8\$)

That is why Biogas?

The best fuel for rural cooking if you have land, water, cows and are not a nomadic!

# **Income and Employment**

#### Increased Income

ADIRE Case Study

- Flexible Work Hours
- Improved Productivity/Morale
- Health/Sanitation



#### Employment Opportunities

- Rural Energy Chain
- Rural Enterprise
- Modern Farming
- Housing and Construction



# Capital Added by 2005 (\$20,000)

ADIRE

Case Study



- $\mathbf{\lambda}$ Brick Machine/ Tube Wells captured 12 surplus labor
- Biogas Plants provided clean cooking fuel, income and leisure Y.
- SPV systems/Solar Lights/ Fans comfortable life for 100 У.
- Hand Tools/ Trolley/ Power Tools convenience and income Y.
- Laptop/ Desktop/Mobile phone/Internet education and skill <u>y</u>
- Candle Moulds/ Sewing/Knitting Machine 5 jobs
- Microfinance All of the above  $\mathbf{\lambda}$













#### Road, Bridge, Canal Work (\$6000)



# Present State of Housing

Iouses

# What is done by 2005... Housing



ADIRE Case Study

> Energy Efficient Low Cost Housing Using Compressed Stabilized Earth Blocks



#### ADIRE Case Study Eco-friendly Low-cost Buildings









House Models taken from Auroville Earth Institute, website

# What is done by 2005... Health & Sanitation



Health Camp, Toilets, Park, Drinking Water (\$2000)





#### World Environment Day Jun 5, 2005









Information Kiosk, Job Training, Off site (\$2000)







#### **Evening School kids with teachers**







# Solar System, Lamps, Fans (\$5000)





#### Solar Panels on the Rooftop





# Economic Development – **Income Generation**

28 Jobs, Dresses, Candles, Brick Machine, Tractor, School, IT, Microfinance (\$10000)



ADIRE Case Study

**Micro financing** 





#### **Dress Designers**



#### **Candle Making**



# Social Engagement..





#### ADIRE Case Study

# What is not done by 2005... Health & Sanitation





Venture Name/ Purpose	Capital Goods/ Inventory	Sources of Energy	Capacity of	Input Employment of Resources		
			Resources	Capital One time	Energy USD/ Y (Material)	Labor No of jobs
Transportation, Farming and Construction	Tractor	Diesel Engine	25 kW Engine	\$8000	\$2000	6
Low Cost Houses Construction	Brick Machine, SPV lighting	Manual Labor	2x20W SPV	\$2500	(Cement)	8
Clothes making	Stitching machine	SPV	1x10 W SPV	\$200	(Clothes)	3
Grocery, Candle making	Mould	SPV/ Paraffin	2x10W SPV	\$200	(Paraffin wax)	3
Solar Shop for leasing and maintenance	Maintaining 22 Lanterns + 3 SHS	Grid and back up SPV	1x10W SPV	\$2000	(Solar systems)	1
Microfinance for homes/shops	Office and small loans	SPV and Biogas	12x10W SPV	\$2000	_	1
Cooking and water heating	Biogas plants	Cow dung	4 x 1 cum + Larger plan	\$600+ ?	(Bricks, Cement)	1
TOTAL	_	_	180W SPV	\$15500	\$2000	23
Canal Construction	Tractor	Labor,	4x10W shared	\$2000	(Cement, Bricks)	4
Road Construction	Tractor, Solar lights	Labor, SPV	4x10W shared	\$3000	(Stones)	4
Bridge / Start up Construction	Tractor, Solar lights	Labor, SPV	4x10W shared	\$12000	(Cement)	4
Health Clinic/ Club house	House, Solar lights	SPV	1x40W	\$500	(Medicine)	1
TOTAL	_	_	80W SPV	\$15500	_	13+
Computer and communication Center /School	Laptop, TV, Video Phone Cam, Room	SHS back up to grid electricity	1x40W SPV	\$1400	\$50	4
Milk and income for poor	4 Cows	Cow dung	Supplier of energy	\$500	_	2
Old age home and health care	Medical appliances	Solar light	1x 40W SPV shared	\$300	\$50	1
Energy Fair and Health programs	Evening illumination	Solar light	1x 40W SPV shared	\$500	\$20	Part time
Cultural programs	Speakers and Mic.	Solar light	1x 40W SPV shared	\$300	\$20	Part time
TOTAL	_		80W SPV	\$3000	\$140	7+

# **Experience** Up to Now

- Unusual Interest and Buzz Created
- Series of NGOs Visiting the Village to Learn SPV uses
- Government Coming Forward with Matching Grants for Infrastructure
- 🝹 Future Promises

ADIRE

Case Study

- Integrated Dairy Farm with Biogas Plant
- Farm Machinery with Biodiesel Plantation
- Workshop with Biomass Power Plant
- A Mobile Hospital and A Modern Village School with Solar Power

## Lessons Learnt

#### 👌 Economic Issues

Conclusion

- Low Income
- High Risk Upfront Cost
- Competing Investment
- High Transaction Costs
   Support thro' Microfinance

#### を Social Issues

- Lack of Aspiration
- Rigid Caste Group
- Low Land Access

**Credible Economic Development** 

- Institutional Issues
  - No Training Institution
  - No Skill and Enterprise
  - Risk Management Structure
     NGO/ Diaspora can lead,
     Govt./ Local Bodies will follow

#### を Cultural Issues

- Individualism/Nepotism
- Satisfied with Too Little
- Emotional Social Customs
- No Avenues for Talent Show
   Harness Cultural Capital

# Harnessing Cultural Capital

#### Dysfunctional

High Local Pollution and Internalized Cost

Conclusion

- Public Open Toilet System: Stomach problems and Malaria
- Daily Domestic Fuel: Fire Wood and Kerosene
- Agricultural Practices: Ancient Cultivation practice

#### **&** No Commercial Orientation

- Dependence on Government or God
- Business and Profit comes only after Good Social Relation
- Barter Economy through Labor Exchange

#### Functionalize

- Low Global Pollution and No External Cost
  - Primary Health, Sanitation, Nourishment
  - Biogas cooking, Solar lighting, Biomass Power
  - Tractors, SPV Pumping, Energy Plantation

#### Social Entrepreneurship

- Self Help using local Skill and Labor
- Business and Profit helps Good Social Relation, practice religion better
- Labor to pay for biogas, solar, health and nourishment

# Ready to Move Ahead

- Skill Training and Socio-Commercial Entrepreneurship
- Willing to Volunteer and Work in other Villages, States
- Creating interest in USA Companies (WPSC, ??)

Conclusion



"These millions of small people with their millions of small pursuits can add up to create the biggest development wonder"

Yunus' vision of trickle-up economics

# Thank You Questions?

